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1. Title of the Invention      Liquid crystal display device

## 2. Scope of Claim

A liquid crystal display device, at least having two substrates which oppose to each other by sandwiching a liquid crystal layer to have one electrode or a plurality of electrodes in the inner face, characterized in that an electrode which opposes to one or less of an electrode connected to an external terminal of one electrode or the plurality of electrodes that are electrically insulated so that a display signal is introduced, and which is uninvolved in display that is not electrically connected to external or other electrodes is provided in the inner face of the opposing substrates.

### 3. Detailed Description of the Invention

#### [Industrial Field of the Invention]

The present invention relates to an electrode structure of a liquid crystal display device.

#### [Prior Art]

As shown in FIG. 4, most of liquid crystal display devices have a structure which includes substrates 23 having a liquid crystal layer 21 and electrodes 22 in an inner face where the liquid crystal layer is sandwiched therebetween. FIG. 3 shows a typical electrode pattern structure of a liquid crystal display device. In FIG. 3, an electrode in an inner face of a top substrate 24 is a signal electrode, which includes a display electrode 25, a lead electrode 26, and a terminal electrode 27. An electrode in an inner face of a bottom substrate 28 is a scanning electrode, and the electrode structure is the same as that of the signal electrode.

#### [Problem to be Solved by the Invention]

In the conventional liquid crystal display device, in FIG. 3 and FIG. 4 mentioned above, the difference between a thickness of the liquid crystal layer corresponding to the electrodes and the other portions is approximately 0.1  $\mu\text{m}$  to 0.2  $\mu\text{m}$ .

Especially in a liquid crystal display element that utilizes birefringence effect, such difference in the thickness of the liquid crystal layer of the liquid crystal display device appears as difference in return tension and this cause to deteriorate the appearance of the display device significantly. In addition, the appearance is deteriorated due to the difference of reflected light in a display surface between an electrode surface and a non-electrode surface according to the reflection of the electrodes. The present invention is invented to compensate such defect mentioned above and it is an object of the invention to resolve the difference in return tension due to a thickness of an electrode and to resolve the difference of reflection.

#### [Means for Solving the Problem]

A liquid crystal display device according to the present invention has electrodes involved in lighting display and electrodes uninvolved in lighting display over an

electrode surface of a substrate. Specifically, the liquid crystal display device according to the present invention is characterized in that an electrode which opposes to one or less of an electrode connected to an external terminal of the electrodes that is display that is not electrically connected to external or other electrodes is provided in an inner face of opposing substrates.

#### [Operation]

According to the foregoing structure of the present invention, an electrode is also formed in a region uninvolved in lighting display which is not necessary in the conventional liquid crystal display device; therefore, a uniform cell gap and reflection of an electrode can be obtained; thus, display quality is improved. A portion where any display signal is added to a display electrode and any new electrode is provided does not affect by display and a new electrode portion is not lighted.

#### [Embodiment]

Hereinafter, the present invention is explained in accordance with embodiments.

##### Embodiment 1

FIGS. 1 (a) and (b) each shows an electrode structure of a liquid crystal display device according to the present invention. FIG. 1 (a) shows a plan view of a signal electrode substrate, and FIG. 1 (b) shows a plan view of a scanning electrode substrate. The signal electrode substrate includes a display electrode 2, a lead electrode 3 for connecting to an external terminal, an external connection terminal electrode 4, and electrodes 5 and 6 according to the invention. The electrode 5 is opposed to one of lead electrodes 8 electrically connected to external over a scanning electrode substrate 7. Therefore, a portion of the electrode 5 is not involved in display at all when the liquid crystal display device is configured. The electrode 6 is not opposed at all to electrodes 8, 9, and 10 electrically connected to external over the substrate 7 and thus the electrode 6 is not involved in display at all. The electrodes over the scanning electrode substrate 7 are also the same as the above-mentioned signal electrode substrate, and electrodes 11 and 12 are provided as an electrode of the present invention. In the liquid crystal display device configured using these two substrates, a liquid crystal layer has a uniform thickness in most of the regions and there is no difference in color tone due to the difference in thickness of an electrode. In addition, reflection in a display surface becomes uniform in an entire surface and the appearance is improved significantly.

## Embodiment 2

FIGS. 2 (a) and (b) each shows another embodiment according to the present invention. Here, FIG. 2 (a) is a signal electrode substrate, and FIG. 2 (b) is a scanning electrode substrate.

In other words, lead electrodes 13 and 14 are formed by extending lead electrodes 3 and 8 for connecting to the external terminal in Embodiment 1 so that a condition of the present invention is satisfied. There are more regions where a liquid crystal layer has the same thickness compared to Embodiment 1 and more uniform color tone and reflection can be obtained; therefore, display quality much preferable to that in Embodiment 1 is offered.

## [Effect of the Invention]

As mentioned above, a liquid crystal display device according to the present invention has excellent appearance, and a liquid crystal display device installed with a liquid crystal display element according to the invention offers preferable display quality. Further, a load during process is hardly increased due to the electrodes as shown in the embodiments and a high-quality liquid crystal display element can be obtained. The present invention is especially effective in a birefringence-mode liquid crystal display device in which uniformity of a liquid crystal layer is required, and is useful as a structure for improving display appearance.

## 4. Brief Description of Drawings

FIGS. 1 (a) and (b) each is a plan view in accordance with an embodiment of the present invention. FIGS. 2 (a) and (b) each is a plan view showing another embodiment. FIGS. 3 and 4 each is a plan view showing a structure of a conventional electrode.

1. signal electrode substrate
2. display electrode
- 3, 8, 13, 14. lead electrode
- 4, 10. external terminal electrode
- 5, 6, 11, 12. electrode according to the present invention
7. scanning electrode substrate
21. liquid crystal layer
22. electrode

- 23. substrate
- 24. top substrate
- 25. bottom substrate
- 26. lead electrode
- 27. one terminal electrode
- 28. display electrode